CLAIMS

1. Method for calibrating a depth sensor of a laser processing device by which a hollow can be formed in the surface of a workpiece,

   characterised in that

   the depths of the measuring points are measured on a calibration surface of known shape,

   the measured values are compared with known values at the respective measuring points of the calibration surface, and

   correction values depending on differences between the measured values and the known values are stored together with the respective coordinates or at memory locations corresponding to the respective coordinates.

A

2. Method according to claim 1, characterised in that the depth sensor uses light emitted from the working position for measuring the depth and the laser light is guided across the surface of the workpiece within a working area predetermined by the device with the aid of a laser beam guidance.

3. Method according to claim 1 or 2, characterised in that the calibration surface is a plane.

4. Method according to claim 3, characterised in that the calibration plane is measured a plurality of times while being displaced in the horizontal direction with respect to the measuring system between the individual measurements, correction values for measuring points corresponding to each other or being located close to each other in the working area being generated depending on all measurements for that measuring point and stored for that measuring point.

5. Method according to one of the preceding claims, characterised in that the distance between measuring points in the feeding direction of the laser

beam is determined by the processing speed of a digital system and by the feeding speed of the laser beam.

6. Method according to claim 3, characterised in that the calibration plane has a waviness of less than 5 µm, preferably less than 1 µm.

7. Method for a depth measurement in a hollow produced by a laser processing device by means of a depth sensor using light emitted from the working position for measuring the depth, the laser light being guided across the surface of the workpiece within a working area predetermined by the device with the aid of a laser beam guidance,

characterised in that

the depth sensor is calibrated by a method according to one of the claims 1 to 6,

a depth is measured at a certain location in the hollow,

the measured value is corrected depending on the position of the location and referring to the stored correction values, and

the corrected value is used as the measured depth.

8. Method according to claim 7, characterised in that the correction is effected by addition and/or multiplication.

9. Method according to claim 7 or 8, characterised in that a correction is effected depending on the depth of the hollow.

10. Method for producing hollow of defined shape in a workpiece using a laser processing device for the layer-wise removal of the material of the workpiece in horizontal layers (S; x, y) in correspondence with the defined shape, the depth (z) of the hollow being continuously measured, particularly according to one of the claims 7 to 9,

characterised in that

the boundaries (x_g, y_g) in the horizontal direction for the substance removal in a following layer (S_{i+1}) are determined from the shape definition of the hollow and depending on the depth (z) of the hollow.

11. Method according to claim 10, characterised in that the thickness (Δz) of a removed layer (S_i) is obtained from measured hollow depths and the boundaries (x_g, y_g) in the horizontal direction for the substance removal in a following layer (S_{i+1}) are also obtained from the shape definition of the hollow and depending on the determined layer thickness (Δz).

12. Method according to claim 10 or 11, characterised in that the determination of the substance removal boundaries of one layer is carried out with reference to stored shape data of the hollow.

A

13. Method for producing a hollow of defined shape in a workpiece using a laser processing device for the layer-wise removal of the material of the workpiece in correspondence with the defined shape, particularly according to one of the claims 10 to 12, the depth of the hollow being continuously measured, particularly according to one of the claims 7 to 9,

characterised in that

the measured values are continuously stored together with the respective coordinates or in memory locations corresponding to the respective coordinates and used for a later control of the laser processing device.

14. Method according to claim 13, characterised in that a stored measured value is used when the laser is close to the position corresponding to the measured value within the same layer and/or when the laser is close to or at the position corresponding to the measured value in a lower layer.

15. Method according to claim 13 of 14, characterised in that a measured value is used for the immediate or a later adjustment of interaction parameters of the laser beam.

16. Method according to claim 15, characterised in that the laser amplitude and/or the pulse exaggeration and/or the scanning ratio of a pulsed laser are adjusted.

17. Method according to one of the claims 13 to 16, characterised in that the stored measured values are used for the removal of a partial layer.

18. Apparatus for a depth measurement in a hollow (10), particularly for carrying out the method according to one of the claims 7 to 9, the hollow being generated by a laser processing device (12 - 18) guiding the laser light across the surface of the workpiece within a working area predetermined by the device with the aid of a laser beam guide, comprising

a depth sensor (70, 71) using light emitted from the working position for the depth measurement and generating a measured value,

characterised by

a calibrating device (72 - 74) suitable for measuring a preferably plane calibration surface and comprising a memory (73) for storing correction values depending on differences between measured values and known values together with the respective coordinates or in memory locations corresponding to the respective coordinates, and

a correction device (74, 75) correcting the measured value depending on the position of the location and with reference to the correction values stored in the memory (74).

19. Apparatus according to claim 18, characterised in that the correction is carried out by addition and/or multiplication.

20. Apparatus according to claim 18 or 19, characterised in that a correction is effected depending on the depth of the hollow.

21. Apparatus for producing a hollow (10) of defined shape in a workpiece (11), particularly for carrying out the method according to one of the claims 10 to 12, comprising

a laser processing device (12 - 18) for a layer-wise removal of the material of the workpiece (11) in horizontal layers (S; x, y) in correspondence with the defined shape, and

a measuring device (70 - 73), particularly according to one of the claims 18 to 20, continuously measuring the depth (z) of the hollow,

characterised by

a control unit (81) determining the boundaries (x_g, y_g) in the horizontal direction for the substance removal in a following layer (S_{i+1}) from the shape definition and depending on the depth (z) of the hollow.

22. Apparatus according to claim 21, characterised in that the control unit comprises a determining means (82) for determining the thickness (Δz) of a removed layer (S_i) from measured hollow depths, the control unit (81) also determining the boundaries (x_g, y_g) in the horizontal direction for the substance removal in a following layer (S_{i+1}) from the shape definition and depending on the determined layer thickness (Δz).

23. Apparatus according to claim 21 or 22, characterised by a memory (83) for storing the shape definition of the hollow (10).

24. Apparatus particularly according to one of the claims 21 to 23 for producing a hollow (10) of defined shape in a workpiece (11), particularly for carrying out the method according to one of the claims 13 to 17, comprising

a laser processing device (12 - 18) for the layer-wise removal of the material of the workpiece (11) in correspondence with the defined shape, and

a measuring device, particularly according to one of the claims 18 to 20, continuously measuring the hollow depth (z),

characterised by

a memory device (91) continuously storing the measured values together with the respective coordinates or in memory locations corresponding to the respective coordinates, and

a control unit (63, 92, 93) controlling the laser processing device (12 - 18) depending on the stored measured values.

25. Apparatus according to claim 24, characterised in that the control unit uses a stored measured value when the laser is positioned close to the position corresponding to the measured value within the same layer and/or when the laser is positioned close to or at the position corresponding to the measured value in a lower layer.

26. Apparatus according to claim 24 or 25, characterised in that the control unit uses a measured value for an immediate or later adjustment of interaction parameters of the laser beam.